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## Proceedings: Aeronautics and Space Science

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## PROCEEDINGS

### AERONAUTICS AND SPACE SCIENCE

#### SESSION A

##### VARIABILITY IN AGN ABSORPTION LINES BASED ON HUBBLE SPACE TELESCOPE/COS DATA

Ben Schmachtenberger and Jack Gabel, Department of Physics, Creighton University, Omaha, NE 68178

We present preliminary results of our project to study mass outflows from a sample of active galactic nuclei (AGN). Our project is based on analysis of ultraviolet spectra obtained with the Cosmic Origins Spectrograph (COS) aboard NASA's *Hubble Space Telescope*. Our study will explore the variability in the observed intrinsic absorption lines that are the signature of AGN outflows. We present an initial report of the variations in absorption strength and discuss implications for the physical nature of the outflows.

##### BALQSO KINETIC LUMINOSITY DETERMINATION WITH C III\* MEASUREMENTS

Daniel McGinnis and Jack Gabel, Department of Physics, Creighton University, Omaha, NE 68178

Mass outflows in active galactic nuclei (AGN) are hypothesized to represent a feedback mechanism by which black hole growth and galaxy formation are linked. In order to assess this claim, a lower limit on the kinetic luminosity of these outflows must be determined. These limits can be constrained by combining computerized photoionization models with spectral measurements. Since the column density of C III\*  $\lambda\lambda 1175$  relative to other carbon ions tracks the volume density of the outflow gas, it provides an ideal proxy for this parameter. We present lower limits on the kinetic luminosity of a sample of AGNs based on measurements of the restframe UV absorption spectra.

##### BREWSTER ANGLE MICROSCOPY AND CHARACTERIZATIONS OF LANGMUIR FILMS

Adrian Sanabria-Diaz and Timothy Reece, Department of Physics and Physical Science, University of Nebraska at Kearney, NE 68849

The behaviors of ferroelectric polymer Langmuir films are observed with the use of a Brewster angle microscope. In general, Langmuir films form a single molecular layer on water because they are often good amphiphiles. Since the polymer Polyvinylidene Fluoride (PVDF) is not a true amphiphile, parameters like solution concentration, water pH, and the amount injected on the trough may have an effect on film behavior and quality. With the aid of a Langmuir-Trough, a Brewster angle microscope, and the autonomous controls of a computer as a nexus between these instruments, different characteristics of the copolymer are studied.

##### SORTING LIGHT'S TOTAL ANGULAR MOMENTUM FOR COMMUNICATION SYSTEMS

Nathan Scott Brady and Liubov Kreminska, Department of Physics and Physical Science, University of Nebraska at Kearney, NE 68849; and Thein An Nguyen, Giovanni Milione, and Robert Alfano, Department of Physics, Institute for Ultrafast Spectroscopy and Lasers, City College of New York, NY 10031

We present a method to multiplex (combine) and demultiplex (separate) eigenstates of light's total angular momentum. Multiplexing is accomplished by utilizing tunable liquid crystal devices which allows for dynamically generating superpositions of light. Demultiplexing is accomplished by using a

device, analogous to a polarizing beam splitter, to separate light's orbital angular momentum. Encoding information in the combined degrees of freedom from the spin and orbital angular momentum, light's total angular momentum has great potential to increase information capacity in future classical and quantum communications.

#### THE PHOSPHORYLATION PATTERN OF RPA2, IN RESPONSE TO DOUBLE-STRAND BREAKS, DIFFERS DEPENDING ON THE LOCATION IN THE CELL AND THE PHASE OF THE CELL CYCLE

Kerry Brader and Gloria Borgstahl, Eppley Institute, University of Nebraska Medical Center, Omaha, NE 68198

Replication protein A (RPA) has multi-faceted roles in DNA metabolism. As the primary eukaryotic ssDNA-binding protein, RPA plays essential roles in DNA replication, recombination, and repair. Multiple regulatory mechanisms have evolved to ensure that homologous recombination takes place at the right time, place and manner. One of these is protein phosphorylation. It is well established that RPA is phosphorylated in response to DNA damage. Here we will deconvolute the phosphorylation pattern of RPA2 in response to the induction of double-stranded breaks induced during S and G<sub>2</sub> phases of the cell cycle. We will demonstrate that there exists a pattern of phosphorylation that differs depending upon the location of the protein (cytosolic, nuclear free, and chromatin-bound) upon induction of DNA damage as well as the location in the cell cycle (S vs. G<sub>2</sub>).

#### THE DIOPHANTINE EQUATION $Ax^4 + By^4 = Cz^4$ IN QUADRATIC FIELDS

Melissa Emory, Department of Mathematics, University of Nebraska at Omaha, NE 68182

A. Aigner proved in 1934 that, except in  $Q(\sqrt{-7})$ , there are no nontrivial quadratic solutions to the Diophantine equation  $x^4 + y^4 = z^4$ . The result was later re-proven by D.K. Faddeev and the argument was simplified by L.J. Mordell. This talk discusses work to extend this result in finding quadratic solutions to  $Ax^4 + By^4 = Cz^4$  and connections to congruent numbers, a Pell's equation, and the Ulam spiral.

#### THE SBML STANDARD TO SHARE COMPUTATIONAL MODELS OF BIOLOGICAL SYSTEMS

Bryan Kowal, Department of Mathematics, University of Nebraska at Omaha, NE 68182

Background: The Cell Collective (<http://www.thecellcollective.org>) is a free web-based collaborative platform for modeling biological processes and virtual cells. To help facilitate exchange of computational models with scientists worldwide, Systems Biology Markup Language (SBML) has been developed. However, SBML didn't support rule-based models (supported by the Cell Collective), a mathematical framework that has become popular due to its scalability towards large-scale models. The Solution: In collaboration with the SBML community, we developed the "qual" package, a SBML extension that makes it possible to describe share qualitative models. This extension not only allows various software tools to exchange computational models, but also enables models that are currently in the Cell Collective to be shared with the scientific community in a standard fashion. Results: The Cell Collective is now capable of exporting and importing models in SBML format. The exported models can be imported into any software that understands the standard SBML format.

#### HIGH SPEED ELECTRO-DISCHARGE DRILLING AND WIRE ELECTRODE-DISCHARGE MACHINING OF TITANIUM ALLOYS FOR AEROSPACE APPLICATIONS

K.P. Rajurkar, Department of Engineering, University of Nebraska-Lincoln, NE 68588

Research objective of this study is to develop a knowledge base for generating complex and highly accurate shapes in titanium alloys for aerospace applications using High Speed Electro-discharge Drilling (HSEDD) and Wire Electro-discharge Machining (WEDM) process. An extensive literature review of properties of titanium alloys, their applications in aerospace and defense industries, and limitations of machining processes currently being used in machining of titanium alloys has been conducted. Experiments using EDM drilling machine (which has been fitted with recently purchased high pressure pump) pressure up to 1500 PSI) and WEDM system available at the Advanced Manufacturing Laboratory at UNL, have been conducted to machine Titanium alloy (Ti-6Al-4V) workpieces by solid copper and tungsten electrodes as well small thin wires in WEDM. The presentation will include process performance results in terms of productivity and surface integrity.

#### ROUTING OVER THE INTERPLANETARY INTERNET

Joyeeta Mukherjee and Byrav Ramamurthy, Department of Computer Science and Engineering,  
University of Nebraska–Lincoln, NE 68588

Future space exploration demands a Space Network that will be able to connect spacecrafts with one another and in turn with Earth's terrestrial Internet and hence efficiently transfer data back and forth. The feasibility of this technology would enable common people to directly access telemetric data from distant planets and satellites. The concept of an Interplanetary Internet (IPN) is only in its incubation stage and considerable amount of common standards and research is required before widespread deployment can occur to make IPN feasible. We have conducted a comprehensive survey of the current space networking technologies and architectures. In the survey, we discuss the IPN and Delay Tolerant Networking (DTN) concepts along with the various space networks that are currently deployed. We propose a design of the IPN and implement it with the Interplanetary Overlay Network (ION) software module on real time physical nodes on the ORBIT testbed. Two space network scenarios are designed and experimentally evaluated to verify the correctness of the network implementation. We also focus on the study of bundle transmission delay and separately evaluate the effect of bundle size and number of bundles. The experimental evaluation provides insights into the factors which caused delay in bundle transmission such as custody refusal, expiration of bundle lifetime and congestion.

#### WIRELESS INTEGRATED RELAY SYSTEM (WIRS)

Shawn Schumacher, Department of Mechanical and Materials Engineering, University of  
Nebraska–Lincoln, NE 68588

This project is one which deals with wirelessly transmitting signals from a device incorporated on a space suit to any other piece of equipment. This device would allow a user, wearing a space suit, to manipulate any equipment on board the spacecraft with the touch of a finger. Technology like this has been developed for normal applications here on earth, but taking this technology and bringing it to life in space poses many obstacles that need to be crossed. Also, this idea references a mainframe computer which will receive the signal from the device on the space suit and will then relay it to the piece of equipment necessary on board. The device that will be attached to the space suit is already being developed at NASA Johnson Space Center in the form of a swatch. Further development may take the interface device into an arm-mounted touch screen display.

#### HUMAN REACTIONS TO FLUCTUATING NOISE CONDITIONS AS PRODUCED BY LOW-BOOM SUPERSONIC AIRCRAFT

Andrew Hathaway and Lily Wang, Charles W. Durham School of Architectural Engineering and  
Construction, University of Nebraska–Lincoln, NE 68588

The goal of this research project is to quantify human performance and perception while being exposed to different types of noise fluctuations. Participants repeatedly performed an arithmetic task under assorted acoustic stimuli and then completed subjective questionnaires. Results from two

completed studies will be presented: one utilizing bursts of noise (similar to low level sonic booms), and one utilizing level fluctuations on a longer time scale (similar to a noisy HVAC unit turning on and off). An ongoing study utilizing bursts of noise accompanied by rattle noise, as may be produced in residential buildings from supersonic aircraft, will also be discussed. Our work coordinates with the current research taking place at NASA Langley Research Center that is evaluating the human response to low level sonic booms inside buildings.

#### NONINVASIVE, AMBULATORY, LONG-TERM, DEEP GASTROINTESTINAL BIOSENSOR AND IMPLANTER

Alfred Tsubaki and Benjamin Terry, Mechanical and Materials Engineering, University of Nebraska–Lincoln, NE 68508

In this work we research and develop a component of a novel biosensing system that will enable the acquisition of long-term, ambulatory, deep implant biometrics without the need for invasive surgery or trained medical personnel for sensor implantation. The complete system has no ex vivo sensing component, so it is completely transparent to the host and offers minimal restrictions to the host's physical activity. We propose to build upon the state-of-the-art by researching methods and a novel system for maintaining the swallowed sensor in vivo, so that it becomes a long-term (>6 months) GI implant. Passive commercial sensors persist in the body typically less than one day, so we are seeking a multiple order of magnitude increase in the duration of intuitive, deep GI sensing.

#### RECONFIGURATION PLANNING OF MODULAR ROBOT UNDER UNCERTAINTY

Ayan Dutta, Prithviraj Dasgupta, and José Baca, Department of Computer Science, University of Nebraska at Omaha, NE 68182; and Carl Nelson, Department of Mechanical Engineering, University of Nebraska–Lincoln, NE 68588

In this research we consider the problem of automatically reconfiguring or changing the shape of a modular self-reconfigurable robot (MSR) when it cannot continue its motion or task in its current shape. To solve the modular robot reconfiguration problem, we propose a novel technique based on a branch of economics called coalition game theory, which is used by people to divide themselves into teams or coalitions. The conventional computer algorithm used for forming coalitions and finding the best coalitions is very expensive to implement in terms of running time and energy (battery power) and not practical to implement on small-scale, modular robots. We have proposed a new, fast algorithm called search UCSG that intelligently reduces the number of coalitions it needs to inspect and eventually finds the best coalitions for the modules of the modular robot. Our proposed technique also incorporates an essential aspect of robotics - uncertainty in operation of the robots movements. We have verified the operation of our algorithm mathematically as well as experimentally using a computer simulated model of a modular robot called ModRED that we are developing as part of the NASA-sponsored ModRED project. Experimental results of our algorithm show that it is able to reconfigure a modular robot while taking significantly lesser time than other state-of-the-art algorithms and is able to form a configuration that is very close or at worst 80% away from the best possible configuration of the modules.

#### DYNAMIC GAIT ADAPTION IN FIXED CONFIGURATION FOR MODULAR SELF-RECONFIGURABLE ROBOTS USING FUZZY LOGIC CONTROL

José Baca, Raj Dasgupta, and Ayan Dutta, Department of Computer Science, University of Nebraska at Omaha, NE 68182; and Carl Nelson, Department of Mechanical and Materials Engineering, University of Nebraska–Lincoln, NE 68588

Modular self-reconfigurable robots (MSRs) are robots that can dynamically adapt their shape and locomotion. They are useful in regions that are difficult for humans to maneuver in, such as in extra-terrestrial environments, inside volcanic craters, etc. When an MSR cannot continue its desired motion

in its current shape, the conventional approach is to reconfigure the MSR by detaching/attaching modules from/to its current shape to form a new shape or configuration. However, it is a costly operation in terms of time and energy, if performed frequently. In this research, we study the problem of how an MSR can continue its motion without reconfiguring its modules, but, by adjusting the way or *gait* with which the modules move. We have proposed a technique from the field of artificial intelligence, called fuzzy logic, for dynamically adapting the gait of MSR modules. We have demonstrated its operation through accurate computer simulations on an MSR called ModRED.

#### EARLY STAGE DEVELOPMENT OF A MEDICAL DEVICE FOR NON-INVASIVE MEASUREMENT OF INTRACRANIAL PRESSURE

Jeff Hawks and Tyler Ketchem, Department of Mechanical and Materials Engineering, University of Nebraska–Lincoln, NE 68588; and Max Twedt, Biological Systems Engineering, University of Nebraska–Lincoln, NE 68588

NASA flight crewmembers experience much lower pressure when they are subject to microgravity. When exposed to this condition, crewmembers experience a cephalic shift, leading to changes in intracranial pressure. These changes may permanently affect vision and lead to other complications caused by increased intracranial pressure. We have constructed a biomimetic phantom of the area surrounding the eye that allows for an accurate induction of blood flow dynamics near the optic nerve head and intend to show a change in flow velocity with applied force. This phantom will be imaged using Doppler ultrasound and will be used to show correlation between intracranial pressure and cerebral blood flow. Our final aim is to develop a small, low power, non-invasive transducer that will be used to bridge pre-flight and post-flight biomarkers with in-flight monitoring of intracranial pressure. This research could also be helpful when studying ocular neuropathies such as glaucoma.

#### COMPLIANT LAPAROSCOPIC SURGICAL GRASPER

Alan Goyzueta, Linxia Gu, and Carl Nelson, Department of Mechanical and Materials Engineering, University of Nebraska–Lincoln, NE 68588; and Brittany Woodin, Department of Biomedical Engineering, University of Iowa, Iowa City, IA 52242

In laparoscopic surgery, long-shafted tools are inserted through small incisions in the patient to access the surgery site with the ultimate goal of reducing trauma to the patient and decreasing recovery time. Through the use of these tools, surgeons lose tactile feedback during tissue manipulation and in some instances apply excessive forces when grasping tissues. The presented device aims to reduce the amount of tissue injury by implementing a compliant jaw that deforms as it grasps soft tissue. Tests were performed to characterize the maximum applicable pull and pinch forces and were compared to a commercially available laparoscopic grasper. Results showed a sigmoidal relationship between pinch force and jaw closure, indicating a safer grasp behavior. Pull force capabilities did not meet expectation due to the fact that the jaws do not currently have teeth.

#### MODULAR JOYSTICK FOR VIRTUAL REALITY SURGICAL SIMULATION

Michael Head and Carl Nelson, Department of Mechanical and Materials Engineering, University of Nebraska–Lincoln, NE 68588; and Ka-Chun Siu, Department of Physical Therapy Education, University of Nebraska Medical Center, Omaha, NE 68198

With modern surgical techniques becoming more and more technically difficult as invasiveness is minimized, the need for surgical training continues to increase. This training is made more difficult due to a lack of tools through which objective measures of performance can be implemented. One method of surgical training that is gaining in popularity is virtual reality simulators. In this project, a modular and reconfigurable joystick was designed and built to evaluate the impact of joystick kinematic topology on fidelity and effectiveness of surgical simulation. The joystick incorporates a full set of degrees of freedom to allow unconstrained motion within the surgical workspace, but permits locking of

specific joints to reproduce tool constraint conditions actually encountered in surgical scenarios. The joystick was equipped with position sensors and a data acquisition system and coupled to a simulated surgical environment.

## AERONAUTICS AND SPACE SCIENCE SECTION

### SESSION B

#### NOVEL ASSISTIVE LOCOMOTOR TOOL FOR GAIT REHABILITATION IN THE ELDERLY

Eric Cutler and Dan Blanke, Department of Health, Physical Education and Recreation,  
University of Nebraska at Omaha, NE 68182

The goal of this research was to investigate the effect of horizontal assistive forces on gait variability in older adults. This novel approach has exciting potential for therapeutic applications in the prevention of falls, a major issue facing older adults. Gait variability has been strongly associated with the incidence of falls amongst the elderly. Our previous work has demonstrated that gait variability can be altered by applying a horizontal assistive force to a person while they walk. However, the effect of these forces on the gait variability of elderly populations was unknown. This research has furthered our understanding of gait variability as it relates to aging, and most importantly how amenable it is to training under these conditions. Results of this research may have laid the groundwork for the development of innovative rehabilitation protocols to improve physical function and decrease risk of falling in older persons.

#### GAIT VARIABILITY HAS NO RELATION TO COGNITIVE PERFORMANCE ON THE PHONETIC FLUENCY TEST

Ryan Hasenkamp and Sara Myers, Department of Health, Physical Education and Recreation,  
University of Nebraska at Omaha, NE 68182

Astronauts experience changes in physical and cognitive function during and after spaceflight. These alterations can lead to decreased performance as astronauts need to accomplish a mission in outer-space. Thus, we sought to determine the interaction between cognitive and physical functioning, which are both affected by spaceflight. Thirteen subjects walked on a treadmill under single task (walking only) and dual task (walking while performing a cognitive task) conditions. Gait was evaluated by recording joint kinematics during walking. The largest Lyapunov Exponent (LyE) was calculated to quantify the temporal organization of variability in the continuous gait time series. The phonetic fluency test was used to assess cognitive function. Results show that the temporal organization of gait is altered (decreased LyE) with addition of the phonetic fluency task. However, there was no significant relationship between phonetic fluency scores and the temporal organization of gait variability.

#### EFFECT OF TACTILE STIMULI ON LOCOMOTOR RHYTHM

Jung Hung Chien, Mukul Mukherjee, Sara Myers, Yawen Yu, Mu Qiao, and Nick Stergiou,  
Nebraska Biomechanics Core Facility, University of Nebraska at Omaha, NE 68182

Astronauts face balance problems after they return to earth from long-duration space flights. These problems arise because exposure to microgravity induces adaptive central reinterpretation of visual, vestibular, and proprioceptive information. Therefore, determining methods to accelerate adaptation and return to normalcy is critical. One way to achieve this is utilization of additional sensory feedback, such as tactile sensation, in the sensorimotor adaptation paradigms. Ten young healthy young ( $27.3 \pm 5$  years) were randomly assigned to either a tactile stimulation (TS) or a non-tactile stimulation (NTS) group. Each participant performed five walking trials: pre-adaptation over ground walking, baseline, split-belt adaptation, catch trial, and post-adaptation over ground walking. Preliminary results

showed enhanced locomotor adaption due to TS in stance time (161%), and swing time (159%). These observations may be because the perturbation to tactile sensory feedback caused by TS forcing participants to undergo multisensory reweighting of locomotor control.

#### UNDERGRADUATE RESEARCH PIPELINE IN MATHEMATICS

Griffith Elder, Department of Mathematics, University of Nebraska at Omaha, NE 68182

This is a report on an effort that is being made in the UNO mathematics department to develop and challenge the pool of strong mathematics students who come to UNO, will graduate and are then likely to pursue a PhD in mathematics or a related field. Since the mini-grant provided funding for two students to take a course in the p-adic numbers and pursue their research projects, this report will discuss these activities and their outcomes.

#### COLLEGE OF SAINT MARY ELEMENTARY SCIENCE OUTREACH PROGRAM

Kelly Lane, Kathryn Dearing, and Jeff Keyte, Department of Biology, College of Saint Mary, Omaha, NE 68106

The College of Saint Mary Elementary Science Outreach Program was developed during the 2011-2012 academic year to provide hands-on science learning activities to local elementary students. The purpose of this program is to increase elementary students' interest in the STEM fields by allowing them to explore science concepts while introducing them to lab equipment and materials delivered through the College of Saint Mary and the NASA Nebraska Space Grant. In the current phase of development, work is focused on expansion, so that the program may involve a greater number of elementary students and CSM science students. A website has been developed as an essential part of this expansion. It allows teachers to explore what the outreach program has to offer, schedule classroom visits, as well as providing science learning resources and activity descriptions. The program is teacher driven, so that K-6 educators may schedule CSM students to lead a specific activity in their classroom based on those available from the website.

#### FOSTERING STUDENT AWARENESS ON GLOBAL CLIMATE CHANGE AND ENVIRONMENTAL STEWARDSHIP THROUGH CURRICULAR AND CO-CURRICULAR ACTIVITIES

Ganesh Naik, Department of Chemistry, College of Saint Mary, Omaha, NE 68106

Global Climate Change and Environmental Stewardship are the key areas which will influence the development of human civilization in the 21<sup>st</sup> century. Educating our students in these areas will help employers find trained task forces, which will empower them to develop new Green strategies/Technologies. To foster students' interest in these areas, we organized activities such as classroom education, workshops, and field trips. Currently we are working on developing a new course on Global Climate Change. This course will address the whole complexity of climate change as an issue, by bringing together the science, impacts, economics, abatement technologies, and policy solutions into one course. In addition, students are also exploring the ways to reduce the negative environmental impact and promote the mantra of "Reduce, Reuse, and Recycle" in the campus/local community by organizing events, performing science demonstrations, visiting local landfills/recycling centers and hosting recycling and litter abatement campaigns.

#### AUTONOMOUS RC CAR

Blake E. Ross, Quinn Fogle, and Bill Spurgeon, Business and Information Technology, Western Nebraska Community College, Scottsbluff, NE 69361

Our goal is to program a radio-controlled car to autonomously navigate a predefined course for competition. We chose to use two Arduino single-board microcontrollers, one microcontroller is used to sample and compile the various sensor data and the other is used to compute where to travel. Sensors



include a GPS module, a compass, wheel speed sensors, and a custom light reflection-based proximity sensor. Bluetooth technology is used to stream real-time data, by transferring our data to a smartphone or PC for debugging purposes. Each pair of latitude and longitude values from the GPS corresponds to a direction for the robot to travel on the currently defined course. The compass is then used to travel the correct direction. If the proximity sensors detect any obstacles, a temporary deviation from the course will be made. We have learned how to work with the hardware and software side of navigating an object autonomously.

#### HIGH-ALTITUDE BALLOON SOLAR PANEL VOLTAGE VARIATION

Josh Gebbie, Department of Math and Natural Science, Metropolitan Community College, Omaha, NE 68111

This experiment tested voltage of solar energy on a high-altitude weather balloon to see if the altitude made any difference in voltage output of a regular solar cell. Due to many factors such as flying above clouds and less scattering of solar rays it was hypothesized that there would be an increase in voltage. After analyzing the data and plotting voltage in respect to altitude, this showed that at high altitudes there was a moderate increase in the solar cells voltage output. The implications for this knowledge could be used to help develop new ways to collect solar energy, an important part of sustainability studies for future energy consumption.

#### MICROBENTHIC ALGAE DENSITIES IN THE DUPLIN WATERSHED

Gina Gilson and John Schalles, Department of Biology, Creighton University, Omaha, NE 68178; and John O'Donnell, Department of Atmospheric Sciences, Creighton University, Omaha, NE 68178

The mudflat region of coastal marsh ecosystems is inhabited by a community of microbenthic algae that contributes significantly to the health and productivity of the marsh. These algae migrate vertically, surfacing at low tide and acting as a food resource to the surrounding ecosystem. Variation in microbenthic algal pigment features were evident in 2006 CALMIT AISA Eagle aerial imagery of the Duplin tidal watershed at Sapelo Island, GA. In 2012, hyperspectral scans were taken of different areas of mudflats using an Ocean Optics USB 2000 Spectroradiometer. Sediment samples were collected at these sites and analyzed to determine true chlorophyll pigment densities. We are analyzing data to find a distinct spectral signal that is unique to the microbenthic algae, eventually enabling remote estimation of algal density from hyperspectral imagery. A chlorophyll absorption spectral feature is evident and appears to deepen with higher chlorophyll concentrations.

#### ESTIMATING UNCERTAINTY OF REFLECTANCE AND ERROR PROPAGATION IN VEGETATION INDICES

Tarlan Razzaghi, Anatoly Gitelson, and Donald Rundquist, School of Natural Resources, University of Nebraska–Lincoln, NE 68588

The Moderate Resolution Imaging Spectroradiometer (MODIS) and Landsat satellites are two of the primary instruments for monitoring global terrestrial vegetation, including crop Bio-Physical Characteristics (BPCs) at regional to global scales. However, due to the coarse spatial resolution (30m/250-m/500-m) and the assumption of a single homogeneous reflectance for an entire pixel, satellites products are affected by sub-pixel mixing, a serious issue in croplands, especially where there is often a considerable discrepancy between the spatial resolution of the imageries and sizes of fields. This provides a challenge to assess the uncertainty of a brightness value across both space and time. The sub-pixel heterogeneity affects the accuracy of satellite-derived BPC estimation. Since vegetation indices computed from coarse-resolution pixels contain uncertainties, another challenge is to accurately model the propagation of uncertainties related to reflectance data as they related to retrieved BPCs. This study undertakes a simulation approach to analyze spatial uncertainty caused by MODIS and Landsat spatial

resolution and address resulting challenges. Hyperspectral Airborne Imaging Spectrometer for Applications (AISA) imagery was collected at 3 meter spatial resolution over irrigated and rainfed corn and soybean fields in 2003 and 2004. For each image, the reflectance values were scaled up from a spatial resolution of  $3 \times 3 \text{ m}^2$  to pixel sizes of  $30 \times 30 \text{ m}^2$ ,  $250 \times 250 \text{ m}^2$  and  $500 \times 500 \text{ m}^2$ . The reflectance uncertainty inside simulated pixels were calculated and modeled as a function of crop phenological stages, pixel sizes, different crop, field water treatment, and for selected spectral bands. The results of this study demonstrate the importance of considering error and uncertainty as essential elements of satellite-derived image data.

#### ESTIMATING SURFACE VISIBILITY ON THE U.S. EAST COAST: INCORPORATING THE AEROSOL VERTICAL PROFILE FROM GEOS-5

Amy Kessner and Jun Wang, Department of Earth and Atmospheric Sciences, University of Nebraska–Lincoln, NE 68588; and Robert Levy, Climate and Radiation Lab, NASA Goddard Space Flight Center, Greenbelt, MD 20771; and Peter Colarco, Atmospheric Chemistry and Dynamics Lab, NASA Goddard Space Flight Center, Greenbelt, MD 20771

In this study, we incorporate the vertical profile of aerosol into aerosol optical depth (AOD) retrievals in order to estimate surface visibility on the U.S. East Coast using satellite remote sensing techniques. First, AOD measurements from the MODerate Resolution Imaging Spectroradiometer (MODIS) are compared with one-minute extinction coefficient ( $\text{visibility} = 3.0/b_{\text{ext}}$ ) data from twenty-two Automated Surface Observing System (ASOS) stations. Then, four methods of incorporating the vertical profile of aerosol from the Goddard Earth Observing System, Version 5 (GEOS-5) are tested. Results show that incorporating the vertical profile of aerosol by scaling the modeled surface  $b_{\text{ext}}$  with the ratio between MODIS AOD and the modeled AOD produced the best overall results, yielding a correlation of 0.72 and a small negative bias of  $-0.03 \text{ km}^{-1}$  for three years of data. This study is among the first to demonstrate the use of the MODIS aerosol product over land to derive surface visibility.

#### EFFECTS OF VOLCANIC EMISSIONS ON THE EARTH-ATMOSPHERE SYSTEM

Levi Boggs and Cui Ge, Department of Earth and Atmospheric Science, University of Nebraska–Lincoln, NE 68588

Many things impact the atmosphere and the environment that we humans today live in. An area that is not well known and only beginning to be understood in the science community is atmospheric aerosols and the impact that they have on earth's climate system. For this research I will be studying the effects of volcanic ash and emissions on the atmosphere and how those emissions are transported globally. I will collect and analyze data about specific volcano eruptions from 2004 until 2012 from multiple continents. I will utilize data and imagery from the NASA instruments MODIS, OMI, CALIOP and MISR to examine the distribution and properties of the volcano emissions. With the aid from NASA instrumentation, personal observations, and official records of the volcano eruptions I will be able to evaluate how those emissions affect the areas to which they are transported.

#### OBSERVING THE TRANSPORTATION OF DUST ON EARTH USING MISR

Carly Baumann and Jun Wang, Department of Earth and Atmospheric Sciences, University of Nebraska–Lincoln, NE 68588

Digitizations of plume heights are vital in determining the motion of wildfires, dust storms, volcano eruptions, and aerosols across the globe on a meteorological and climatological scale. Accurate height and wind information can help predict the transformation of these particles across various terrains and possible impacts on local environment.

Linkages between dust plume information at the dust sources and dust properties in the downwind regions will be evaluated using the Multi-angle Imaging SpectroRadiometer (MISR) plume digitizations

and MISR aerosol products. The analysis of the MISR images will be done through the use of MISR Interactive eXplorer (MINX) software. MINX output includes plume extent, precise wind-corrected heights for visible plume tops, wind speeds at the plume top, top-of-atmosphere albedo, aerosol properties, and information on the radiative power and brightness temperature of fires associated with the plumes, when available.

#### ARGOS AND MICROGRAVITY FREE FLYER EVALUATION

Christian Laney, Department of Electrical Engineering; and Jacob Reher, Department of Mechanical Engineering, University of Nebraska–Lincoln, NE 68588

The University of Nebraska–Lincoln Microgravity Team is 1 of 15 schools in the nation selected to participate in the NASA Microgravity University program. The team will evaluate the ability of NASA's Active Response Gravity Offload System (ARGOS) to provide a microgravity environment for a free-flying vehicle. The team is developing an octa-copter free flyer to be tested in both ARGOS and plane-induced microgravity environments. The team's devised data collection method will involve a combination of data sources that may include stereo-motion capture camera system and inertial guidance unit aspects. Parabolic flight maneuvers of a reduced gravity aircraft provide a testing environment against which to compare the ARGOS. Specifically, the team will be investigating any positional error between the data collected in induced microgravity onboard the plane and the data collected on the ARGOS. Ultimately, the data should allow for effective evaluation of the ARGOS and for the optimal tuning of the free flyer's control system.

#### UNL LUNABOTICS TEAM: DESIGNING A ROBOT FOR THE NASA LUNABOTICS ROBOT COMPETITION

Kevin Kreis, Department of Mechanical Engineering; and Avery Quandt, Department of Computer Engineering, University of Nebraska–Lincoln, NE 68588

With Curiosity safely landed we are about to enter a new era of exploring Mars, which shows us how important autonomous exploration vehicles are to space exploration. This will be our teams second year competing in the NASA Lunabotics competition. This robot will compete in a simulated lunar environment at the NASA Lunabotics competition this May. NASA Lunabotics is a competition working towards extending and sustaining human activities across the solar system. Most importantly, this competition is helping to train the next generation of human space exploration. The design and construction of this robot will give members invaluable experience on the application of their coursework. It will provide them with a chance to work on a project and see a physical result, something that is lacking in the course curriculum. The Lunabot will measure 2.5 feet by 5 feet and the weight limit is 176 pounds. The robot needs to be capable of collecting and depositing at least 10kg of lunar regolith simulant. During our first year of competition we learned a lot about the rigors a robot must survive in an alien environment. For instance we learned about how difficult it can be to properly seal your robot, and how you have to pay attention to ensure everything is properly reinforced. This year we have decided to go with a more complicated (backhoe style) digging mechanism on our robot. We wanted to challenge ourselves to create a complex machine and ensure it works as efficiently as possible. Our team believes that the more difficult the design, the more we will learn in the process of bringing it to life.

#### DESIGN, BUILD, FLY

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For the 2012/13 AIAA Design/Build/Fly competition, teams must engineer and construct a remote control airplane that can carry various payloads of internal and external missiles with a maximum payload of 3 lbs. The airplane must also be able to take off within a 30ft by 30ft square. Light planes with a short wingspan and short length receive higher scores. The UNL Design/Build/Fly team is

building a single motor bi-plane this year. The bi-plane configuration makes the plane heavier, but allows it to have a shorter wingspan and greater structural integrity.

#### UNIVERSITY STUDENT LAUNCH INITIATIVE

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The best description of the University Student Launch Initiative (USLI) is on the NASA education website. "NASA University Student Launch Initiative, or USLI, is a competition that challenges university-level students to design, build and launch a reusable rocket with a scientific or engineering payload to one mile above ground level, or AGL. The project engages students in scientific research and real-world engineering processes with NASA engineers." This competition will last a full eight months of design, testing and building. The competition goes farther than just building a rocket, you also have to: write multiple design reports, conduct video conferences with NASA engineers, and put together outreach event that promote STEM based activities in the community. Our biggest goal for this year's competition is to provide the best outreach out of all the teams participating.

#### EHD THIN FILM BOILING IN MICROGRAVITY ENVIRONMENTS

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RockSat-C is a program for students to design and build a sounding rocket payload, and launch the payload on a rocket from Wallops Flight Facility! Payloads shall be student based with faculty and/or industry involvement only. This year, the UNL RSC team is closely collaborating with Goddard Space Flight Center to design and build an experimental payload. This experiment will test and acquire data on thin film boiling via an EHD system in microgravity.

On October 28, 2011, the Suomi National Polar-orbiting Partnership (NPP) satellite was launched and now orbits 824 km above the earth in sun-synchronous orbit. The satellite carries a plethora of instruments; however, one instrument in particular, the Visible Infrared Imaging Spectrometer (VIIRS), is of special interest because it enables nocturnal detection of visible light from sources including fires and cities with its Day-Night-Band (DNB). While the DNB has a wide variety of applications, it shows much promise in improving retrieval of fire properties at night. By using freely-downloadable data from the U.S. Government, sub-pixel fire area and temperature can be determined from the 4  $\mu\text{m}$  and 11  $\mu\text{m}$  channels, and with the inclusion of the DNB, flaming versus smoldering area can also be calculated. An algorithm can be created to provide more realistic fire size and emission estimates, which can lead to improved operational fire suppression by improving resource allocation.

#### COMBINING SATELLITE OBSERVATIONS OF FIRE ACTIVITY AND NUMERICAL WEATHER PREDICTION TO IMPROVE THE PREDICTION OF SMOKE EMISSIONS

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Smoke emissions estimates used in air quality and visibility forecasting applications are currently limited by the information content of satellite fire observations. This study explores the potential benefits of a recently developed sub-pixel-based calculation of fire radiative power ( $\text{FRP}_f$ ) from the MODerate Resolution Imaging Spectroradiometer (MODIS), which provides more precise estimates of the radiant energy (over the retrieved fire area) that in turn, improves estimates of the thermal buoyancy of smoke plumes. Results show that unlike the current FRP product, the incorporation of  $\text{FRP}_f$  produces a statistically significant correlation ( $R = 0.42$ ) with smoke plume height data provided by the Multi-angle Imaging SpectroRadiometer (MISR) and several meteorological variables, such as surface wind speed and temperature, which may be useful for discerning cases where smoke was injected above the boundary layer. Drawing from recent advances in numerical weather prediction (NWP), an automated, 24-hour prediction of satellite fire activity is also developed. The ultimate goal is to combine NWP data and satellite fire observations to improve both analysis and prediction of biomass-burning emissions.

#### SEARCH FOR ASYMMETRIC INTERACTIONS BETWEEN CHIRAL MOLECULES AND SPIN-POLARIZED ELECTRONS

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We present preliminary asymmetry results for transmission of longitudinally spin-polarized electrons through a vapor of chirally-pure bromocamphor ( $\text{C}_{10}\text{H}_{15}\text{BrO}$ ) molecules. We define the asymmetry for transmission as  $A = [(I_{\uparrow} - I_{\downarrow})/(I_{\uparrow} + I_{\downarrow})]_R - [(I_{\uparrow} - I_{\downarrow})/(I_{\uparrow} + I_{\downarrow})]_L$ , where  $I_{\uparrow}$  ( $I_{\downarrow}$ ) is the transmitted current measured for spin-up (spin-down) electrons and “L” and “R” subscripts correspond to left- and right-handed chirality of molecules. At present, we have measured  $A$  at 1.5 eV electron scattering energy to be  $(5.4 \pm 2.5) \times 10^{-5}$  when the transmitted, magnetically collimated electron beam is attenuated to 10% of its initial value. This should be compared with the measurements of Mayer *et al.*, where they report an asymmetry (by our definition) of  $\sim (3.4 \pm 0.2) \times 10^{-4}$  for the same incident energy and electron beam attenuation [1]. We discuss possible reasons for this discrepancy.

[1] S. Mayer, C. Nolting, and J. Kessler, J. Phys. B 29, 3497 (1996).

#### AUTOIGNITION IN AN UNSTRAINED METHANOL/AIR MIXING LAYER

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Autoignition in an unstrained, laminar mixing layer of methanol/air is investigated using detailed reaction mechanism and full multicomponent mass diffusion formulation. The temperature of the fuel stream is varied from 400 K to 1200 K, whereas the oxidizer stream is held at a fixed temperature of

1200 K. The calculations are performed for pressure  $p = 1$  bar. Transient evolution of the autoignition kernel from initial partially premixed flame structures to final diffusion flame is demonstrated. The flame structures have been analyzed for individual heat release rates. For equal fuel and oxidizer stream temperatures (1200 K), heat release in extremely fuel rich locations (with mixture fraction values up to 0.8) is found. A transient triple flame structure (two deflagrations and, one diffusion flame) is shown to exist even in cases when the temperature difference between the two streams is large. The heat release rates in the deflagrations depend on the temperatures of the two streams. When compared with the surviving diffusion flame, the heat release rate in the short-lived deflagrations is one to two orders of magnitude higher. It is shown that increasing the fuel stream temperature also decrease the ignition delay time in the mixing layer.

#### ANALYSIS OF THE HST/COS SPECTRUM OF THE MASS OUTFLOW IN SEYFERT 1 GALAXY MRK 279

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We present a preliminary analysis of an ultraviolet (UV) spectrum of the Seyfert 1 galaxy MRK 279. We're studying the intrinsic UV absorption lines of MRK 279 which indicate mass outflow from the Active Galactic Nucleus (AGN). These observations were made with the Cosmic Origin Spectrograph (COS) aboard NASA's Hubble Space Telescope (HST). We present measurements of the absorption features and explore variability of the outflow spectra by comparing to previous HST spectra.

#### CHARACTERIZATION OF A 5.8KV SiC PIN DIODE FOR ELECTRIC SPACE PROPULSION APPLICATIONS

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A new 5.8kV SiC PiN diode from Cree, Inc was characterized under static and dynamic conditions to determine suitability for use in the Faraday Accelerator with Radio-frequency Assisted Discharge (FARAD) pulsed electric thruster drive circuit. Of primary interest are losses associated with diode reverse recovery, as well as maximum peak current handling capability for a typical thruster pulse duration of 10 $\mu$ s. Experimental switching waveforms collected at 25°C are presented. These data provide strong evidence that, under the same conditions, reverse recovery time, peak current, and peak charge are significantly less for the newly developed SiC diode than for a comparable Si fast recovery diode. This supports the idea that a SiC diode will reduce energy loss in the FARAD drive circuit. This increased efficiency in turn decreases the amount of propellant that must be stored on board a spacecraft for a given mission, reducing overall weight and freeing space for scientific payloads and/or passengers.

#### WIRELESS POWER TRANSFER: DESIGN AND APPLICATION

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A common problem shared by nearly all technology is finding a way to power it, whether it is plugged into an outlet or carries a battery. Eventually, wireless power will be a viable tool to help power devices and sensors. When coupled with unmanned aerial vehicles (UAVs), devices in remote locations will be easily accessed and charged. The main principle behind this research is magnetic resonance. Tests were conducted on power transfer between transmission coils of a small quad copter scale (radius = 23cm) to receiving coils of a smaller scale (radius = 3.9cm). This setup was used to power an LED at a distance of up to around .75 meters. Optimal range for power transfer has been found to be within one radius of the transmission coil. Transmission through water appears to be nearly as effective as through air.

#### FORCE SENSING OF GRASPING EVENTS FOR MINIATURE SURGICAL ROBOTS

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Surgeons prefer to be able to palpate the tissue for diagnosis during surgical procedures. The open nature of traditional surgery provides adequate access to the patient, but the more advanced techniques prevent the surgeon from this direct access. These minimally invasive techniques rely on specialized tools passed into the body through several small incisions. Tools used in these procedures do not normally provide reliable feedback; however, the application of robots to these techniques creates the potential for accurate feedback. Two-armed miniature surgical robots have been developed that can perform surgical tasks through manipulation of standard surgical tools. These tools have been instrumented with a load cell such that the closing force of the grasper can be measured. From this value, the contact force can be passed on to the surgeon. Initial testing has shown measureable differences in the characteristic load curves that result from grasping different types of material.

#### UNDERSTANDING WALKING AND BREATHING COUPLING WHEN ABNORMAL BREATHING PATTERNS ARE PRESENT

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Astronauts suffer from general cardiovascular deconditioning and it is feasible that deconditioning in breathing biological rhythms could have an effect on the overall function. Biological rhythms mutually attract to one another. Known as coupling, each rhythm is influenced by the other's intrinsic rhythm, yet, maintains its own intrinsic rhythm. A coupled relationship between walking and breathing has been observed in humans and an optimal strength of coupling between these two rhythms is characterized by energy economization during walking. What we do not know is if both rhythms demonstrate an abnormal intrinsic rhythm due to space flight, does this affect the ability of the rhythms to couple. Over the past year, significant time has been spent on developing a methodology that can record breathing and walking patterns simultaneously. A physiological monitor was purchased and substantial time was devoted to writing LabView code that would synchronize this device with 3-dimensional motion capture.

#### EXAMINING THE QUALITY OF MODIS REFLECTANCE PRODUCTS USING A FOUR-BAND SPECTRORADIOMETER

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There is a need to validate satellite products. This study examines the quality of MODIS reflectance products over a two year period (2010-2011) in three agricultural fields near Mead, Nebraska using 4-band spectroradiometers. A pair of four-band spectroradiometers (SKYE instruments) at each site collect downwelling irradiance and upwelling radiance in four spectral regions (green, red, red edge, and near infrared). Reflectance was determined at half hour intervals. The MODIS reflectance products for both Terra and Aqua sensors were compared to their respective SKYE reflectance and vegetation indices (VIs; NDVI, EVI, WDRVI). These relationships were quite strong, suggesting that the atmospheric correction and pixel selection criteria for MODIS reflectance and VI products are accurate. Using ground measured LAI measurements and GPP measured by eddy-covariance flux towers, we found that both the SKYE and MODIS spectroradiometers are able to provide accurate estimation of crop biophysical characteristics such as LAI, biomass, and GPP.

#### INVESTIGATING LAND AND ATMOSPHERE CHARACTERISTICS DURING THE 2012

## CENTRAL PLAINS DROUGHT USING MODIS AND TRMM PRODUCTS

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Droughts are known to cause both natural and economical impacts as a result of a deficit in precipitation for a season or longer. Unlike most natural hazards (tornadoes, earthquakes, etc.), droughts approach slowly and the duration is difficult to forecast. During 2012 in the Central Plains of the United States, lack of precipitation and high heat led to a record drought in comparison to the last ten years. This research will focus on using remote sensing to study natural drought impacts to land surface and atmospheric properties using the Moderate Resolution Imaging Spectroradiometer (MODIS) sensor aboard EOS-Terra and EOS-Aqua as well as the precipitation radar and microwave imager aboard the Tropical Rainfall Measuring Mission (TRMM) satellite. MODIS products will include day/night land surface temperatures, vegetation indices, and fire characteristics. The average accumulated monthly precipitation product from the TRMM satellite will also be included.

## ANTHROPOLOGY

### A MARXIST APPROACH TO US HISTORICAL ARCHAEOLOGY: A REVIEW AND SUMMARY OF THE HISTORY AND APPLICATION OF MARXISM ON THE FIELD OF HISTORICAL ARCHAEOLOGY IN THE US

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Throughout the history of Historical Archaeology in the US its practitioners have been constantly striving for greater relevance and acceptance of the field as a viable and worthwhile area of study. This has seen the coming and going of both the processual and post-processual movements in the field. The latter of which created a new focus of study in both capitalism and marginality. In my paper I will show how the historical trends in the field have lead it to take up the use of a Marxist approach to archaeology in order to study both capitalism and class in an effective manner. I will also demonstrate that by taking up the use of Marxism archaeologists have been giving a unique chance to broaden the applicability and relevance of their field to a new class of audience through the critical look of archaeologies role in the US capitalistic system and how it can be changed and improved. I present two case studies from two carefully chosen dig sites, a cutlery factory in western Massachusetts and the Ludlow Massacre site in Southern Colorado, for their ability to provide modern, poignant and gripping real life examples of my arguments.

### JOHN COLLIER, ANTHROPOLOGY, AND THE INDIAN NEW DEAL

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This presentation contends that U.S. Indian Commissioner John Collier was an avid believer in the use of science to solve the “Indian problem,” the social and economic malaise griping the nation’s Native American population. Collier hoped that the use of scientific studies would provide detailed descriptions and solutions to the pressing problems of the nation’s First Americans. In the use of science he was especially interested in Anthropology, first seeking the aid of leading anthropologist Franz Boaz and, in formulating what would later become the Indian New Deal, seeking the assistance of Boaz protégé Alfred L. Kroeber. This presentation reviews Colliers application of Anthropology into his years as U.S. Indian Commissioner, including what Collier described as the two “epochs” of anthropological study during his tenure: a tentative early phase when anthropologists worked largely in isolation to obtain knowledge of particular questions and a phase described as a more mature epoch when field studies, reminiscent of *Bronislaw Malinowski*’s concept of functional anthropology, held sway. Collier believed that these studies allowed a deep investigation into Indian motivations and offered insight into human universals. This presentation will explore this use of Applied Anthropology and its use as a form